BACKGROUND OF THE INVENTION

In a synchronized wireless communications system, a common method for a remote mobile unit to request access to the system is to send an uplink access message to a fixed base station. An example of this uplink access message is a random access channel (RACH) message found in a time division multiple access (TDMA) type Global System for Mobile Communications (GSM) system. Each time a base station detects a RACH message, physical and logical resources are allocated for the remote mobile unit to communicate. The physical and logical resources in a typical system are limited, resulting in degradation of system performance and preventing other potential mobile units from accessing the system whenever a RACH message is falsely detected. The development of reliable procedures to minimize false RACH message has a very high priority in the system. These procedures should be designed to have a negligible adverse impact on the detection sensitivity of actual RACH messages.

In a conventional GSM system, there are built in protections to maximize signal detection that do not address the problem of false detection. For example, information bits in a RACH message are encoded with cyclical redundancy code (CRC) parity check bits that allow for noise corrupted RACH messages to be detected and discarded by the base station. However, this CRC parity check may still allow false RACH messages to be detected. Since the base station is detecting the presence of RACH messages many times a second, other criteria that characterizes the quality of the received signal need to be developed to avoid overwhelming the resources of the base station with false RACH message

detections. Therefore, it is desirable to provide a technique that reduces or avoids the detection of false access messages in order prevent unnecessary allocation of system resources.

SUMMARY OF THE INVENTION

From the foregoing, it may be appreciated by those skilled in the art that a need has arisen for the ability to eliminate the detection of false access messages and their impact on system resource allocation. In accordance with the present invention, a method and system for reducing false detections of access signals are provided that substantially eliminate or greatly reduce disadvantages and problems of conventional access signal detection.

According to an embodiment of the present invention, there is provided a method for reducing false detections of access signals that includes receiving a presumed access signal, demodulating the presumed access signal, and performing equalization on the presumed access signal. A received sequence of bits carried by the presumed access signal is compared to a reference sequence of bits. A number of received sequence of bits matching the reference sequence of bits is identified. A false detection is determined in response to the number falling below a threshold number.

The present invention provides various technical advantages over conventional access signal detection. For example, one technical advantage is to identify whether a presumed access signal is an actual access signal in order to reduce the number of false access detections. Another technical advantage is to compare a received sequence of bits after signal equalization to a reference sequence of bits. Yet another technical advantage is to identify a false access signal in response to a number of matches of the received sequence of bits falling below a desired threshold. Still another

technical advantage is to incorporate known signal quality analysis techniques with the present false access detection technique to further eliminate detection of false access messages. Other technical advantages may be readily ascertainable by those skilled in the art from the following figures, description, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, wherein like reference numbers represent like parts, in which:

FIGURE 1 illustrates a block diagram of a wireless telecommunications network;

FIGURE 2 illustrates a block diagram of a base station in the wireless telecommunications network for reducing false detections of access signals;

FIGURE 3 illustrates an exemplary format of an access signal;

FIGURE 4 illustrates a technique performed by the system for comparing bit sequences of received access signals.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 is a block diagram of a wireless telecommunications network 10. Network 10 includes a plurality of base transceiver stations 12 that send and receive wireless communications to a plurality of mobile units 14. Network 10 provides a capability to establish a communication link between mobile units 14 or between a mobile unit 14 and any of a plurality of network facilities, including a private branch exchange 16, an integrated services data network 18, a public switched telephone network 20 and Internet 22. Communication links may also be established between mobile unit 14 and a local or wide area network as desired. A hub 24 interconnects mobile units 14 with the network facilities. A router 26 directs calls among the various network facilities. Gateways 28 provide interconnection interfaces and protocol conversion capability between router 26 and the network facilities. A gatekeeper 29 provides the functions to register mobile units 14, permit access through network 10, translate called numbers, and route calls appropriately.

In one embodiment, base transceiver stations 12 and gatekeeper 30 include the necessary functions to establish communications links for mobile units 14 in a Global System for Mobile Communications (GSM) and H.323 domain environment. In such an environment, a mobile unit 14 desiring a communication link within network 10 sends an uplink access signal to a base transceiver station 12. Base transceiver station 12 looks for and detects this uplink access signal in order to allocate physical and logical resources for the communication link. Because resources are limited within network 10,

base transceiver station 12 includes a technique to ensure that signals detected during monitoring operations are actual access signals before needlessly allocating the necessary resources.

FIGURE 2 is a block diagram of base station 12 that reduces false detections of access signals. Base station 12 continuously tests for the presence of access signals in order to allocate communication resources for remote mobile unit 14. Base station 12 includes a demodulator 30, an equalizer 32, and a decoder 34. Demodulator 30 determines a time of arrival for an access signal. The time of arrival is the start of an access burst. The time of arrival is estimated by comparing a received sequence of bits to an expected, or reference, sequence of bits. The received sequence of bits are used to establish timing synchronization between a remote mobile unit 14 and base station 12. The time of arrival is expected to occur within the first N bits of synchronization, where N is dependent upon the size of the network of base stations. If a time of arrival is not determined within the first N bits, anything received by demodulator 30 is discarded as a false access signal.

FIGURE 3 is an example of an access signal 40. The access signal shown is a typical random access channel message according to the GSM standard. Access signal 40 includes a training sequence of 41 bits, coded data of 36 bits, and a guard period of 68.25 bits. Time of arrival is determined by looking at the first 8 bits of the training sequence. Once a time of arrival has been established, the access signal is passed on to equalizer 32.

Equalizer 32 provides for elimination of the effects of multi-path delay spread and fading that occurs as a result of transmission of the access signal through the air, especially of a trellis coded GMSK modulated burst. In many cases, a severely degraded signal of trellis coded modulation due to multi-path fading can be corrected by equalizer 32. Equalization of burst samples is a computationally intensive procedure and typically only performed on the coded data bits in the access burst. In the present invention, equalization is performed on the training sequence of access signal 40 in order to deliver dramatic gains in false access signal detection.

FIGURE 4 shows an example of the training sequence bit comparisons performed on the received access signal. After equalization, each bit of the received training sequence is compared to a corresponding bit of a reference training sequence. For bits that match, a positive value is assigned. For bits that do not match, a negative value is assigned. The positive values are summed to obtain a number, a burst confidence metric, that is compared to a threshold number. For the example shown in FIGURE 4, 35 of the 41 bits of the received training sequence matched the reference training sequence. To identify the access signal as an actual access signal, the threshold number would need to be 35 or higher. If the threshold number is 34 or lower, the access signal would be discarded as being a false access signal. The threshold number may be set to any amount according to a desired sensitivity of the access signal detection and the burst confidence metric may be

required to exceed the threshold number before an actual access signal is identified.

Decoder 34 performs convolutional decoding of the access signal received from equalizer 32. Decoder 34 may also provide an additional access signal detection capability. Decoder 34 may perform a cyclical redundancy code parity check on the access signal. If the access signal fails the parity check, the access signal is discarded. For an access signal encoded with 6 parity check bits, for example, there is a 1 in 64 probability that a false access signal will pass the parity check. If the access signal passes the parity check, decoder 34 may re-encode the access signal and compare the re-encoded access signal to the received access signal. This comparison provides an estimate of the number of bit errors occurring in the transmission channel. In this manner, advantage can be taken of redundancy bits introduced in the convolutional encoding process. The access signal can be discarded if the number of bit errors exceeds a bit error threshold. For rate 1/2 convolutional encoding for example, about 1 in 128 false access signals may pass this bit error check.

Suppose that the burst which is being tested for the presence of an access message contains only noise or only uncorrelated interference from an adjacent timeslot or cell. The number of false access signals being passed through to resource allocation dwindles by including the detection techniques discussed above. By using time of arrival where for example 1 in 8 false access signals fails to be detected, cyclical redundancy parity checks where for example 1 in 64 false access signals fails to be detected, and bit error checking where for example 1

in 128 false access signals fails to be detected, the number of false access signals escaping detection falls to 1 in 65536. In the GSM system for example with approximately 115 access signals per signaling channel per second being tested, base transceiver station 12 falsely detects an access signal and initiates resource allocation about once every ten minutes. After equalization and burst confidence metric determination, an average match due to noise and channel interference is about 25.5 of the 41 training sequence samples. If a threshold value of 35 matched samples is selected, only about 1 of 750 false access signals fails to be detected. The threshold value of 35, though providing 6 bits of error headroom, has a negligible impact on access signal detection sensitivity. By also using the burst confidence metric, base transceiver station 12 will falsely detect an access signal about once every 5 days. Thus, the allocation of resources to false access signals is drastically reduced.

Thus, it is apparent that there has been provided, in accordance with the present invention, a method and system for reducing false detections of access signals that satisfy the advantages set forth above. Although the present invention has been described in detail, it should be understood that various changes, substitutions, and alterations may be readily ascertainable by those skilled in the art. For example, though discussed with respect to a GSM system, the present invention may equally apply to CDMA and/or IS-136 systems as well as other similar standards. Other examples may be made herein without departing from the spirit and scope of the present invention as defined by the following claims.